NBSIR 73-176 (R)

Comparison of Photon Interaction Data Sets. VI. McGuire and Kaman Photoeffect Data.

G. L. Simmons,* J. H. Hubbell**

*Science Applications, Inc.
Huntsville, Alabama 35805

**Center for Radiation Research
Institute for Basic Standards
National Bureau of Standards
Washington, D. C. 20234

May 1973

Interim Report for Period January March 1973

Prepared for
Defense Nuclear Agency
Washington, D. C. 20234

NBSIR 73-176

COMPARISON OF PHOTON INTERACTION DATA SETS. VI. MCGUIRE AND KAMAN PHOTOEFFECT DATA.

G. L. Simmons,* J. H. Hubbell**

*Science Applications, Inc.
Huntsville, Alabama 35805

**Center for Radiation Research
Institute for Basic Standards
National Bureau of Standards
Washington, D. C. 20234

May 1973

Interim Report for Period January-March 1973

This report is to be superseded by a future publication which will receive general distribution and should be cited as a reference. Please consult the NBS Office of Technical Information and Publications to obtain the proper citation.

Prepared for
Defense Nuclear Agency
Washington, D. C. 20234

U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

Abstract

Photoeffect cross sections calculated by McGuire, covering the energy range 0.0062 to 62.0 keV for elements with Z = 2 to 54, are compared with values interpolated from results calculated by Veigele et al (Kaman) which cover the energy range 0.1 to between 1.0 and 8.0 keV. This comparison is presented in the form of percent differences between these two data sets, with the Kaman values taken as the reference set. The cross sections are listed and the differences are tabulated over the energy range 0.103 to 62.0 keV. At the higher energies (above between 1.0 and 8.0 keV) in this region of overlap, the Kaman values were fitted to experimental data, rather than calculated from theory. Discrepancies ranged from less than 3% up to as much as a factor of ten in the iodine M_{IV} - M_V edge region at 0.620 keV. From this comparison, and from graphical comparison of both sets with experimental data for carbon, aluminum and tin, we estimate that for Z = 2 to 54 the envelope of uncertainty of present calculated values in the region 0.1 to 1.0 keV is of the order of ± 20% except in the presence of resonance absorption features where the uncertainty can be an order of magnitude.

I. Introduction

In a previous report (IV. Kaman and ENDF/B) in this series,[1/] we presented a comparison of the photon cross section data set (0.1 to 1000 keV, Z = 1 to 94) given by Veigele et al[2,3/] (Kaman Corp.) with the ENDF/B library data set[4/] (1 keV to 100 MeV, 87 elements with Z = 1 to 94).

In that report we also included a comparison of the total attenuation coefficients in the Kaman set with the light-element, low-Z set by Henke and Elgin.[8/] The Henke and Elgin set, extending over the range 0.03 to 6.0 keV for Z = 2 to 18, was fitted and interpolated from available experimental data.

The Kaman cross section set in the region 0.1 to 1.0 keV, on the other hand, was calculated from theory for all elements. For elements with Z greater than 21 (Sc) these calculations were extended to energies higher than 1 keV, in one case up to 8.0 keV (Pu, Z = 94), above which, except for hydrogen, the Kaman set consists of values derived from experimental data.

In this low-energy region, particularly below 1 keV, the total attenuation coefficient is comprised almost entirely of the photoeffect cross section as indicated in Table I. The remaining portions of the total cross section, the coherent and incoherent scattering contributions, were calculated by means of the customary scattering-factor, impulse-approximation approach throughout the 0.1 to 1000. keV energy range of the Kaman set. These scattering cross section contributions enter only as small or negligible corrections to the total cross section in the range 0.1 to 1.0 keV. Hence in this low energy region an examination of the total attenuation coefficient reduces essentially to an examination of the photoeffect cross section.

In addition to the Kaman calculation of the photoeffect cross sections below 1 keV, there also exists an independent systematic calculation of photoeffect cross sections by McGuire[9/] extending over the region

0.0062 keV (2000Å) to 62.0 keV (0.2Å) for elements with Z = 2 to 54. In this report we compare the McGuire and Kaman theoretical photoeffect values in the region 0.103 keV (120Å) to 62.0 keV (0.2Å), Z = 2 to 54.

The theoretical basis and calculational procedure for the Kaman low-energy photoeffect cross section computation were briefly described in report IV of this series.[1/] We similarly describe briefly as follows the McGuire calculations and indicate some of the similarities and differences with respect to the Kaman calculation.

II. McGuire Photoeffect Calculations

Both the Kaman and McGuire soft x-ray theoretical photoeffect cross sections were calculated using the dipole central-field model discussed in detail by Cooper.[10/] In this model, the contribution $\tau_{n\ell}$ of the $n\ell$ subshell to the total photoionization cross section is

$$\tau_{n\ell} = \frac{4}{3}\pi\alpha a_0^2 N_{n\ell} h\nu \left[\left(\frac{\ell}{2\ell+1}\right)R^2_{\ell-1} + \left(\frac{\ell+1}{2\ell+1}\right)R^2_{\ell+1}\right] \qquad (1)$$

where α is the fine-structure constant, a_0 is the Bohr radius, $N_{n\ell}$ is the subshell occupation number, $h\nu$ is the photon energy in Rydbergs, and $R_{\ell\pm1}$ are the radial matrix elements for the transition of the electron from the bound state with orbital quantum number ℓ to continuum states with $\ell' = \ell \pm 1$.

For the evaluations of the radial matrix elements $R_{\ell\pm1}$, both the Kaman and McGuire calculations used the dipole-length expression.

$$R_{\ell\pm1} = \int_0^\infty P_{n\ell}(r)\, r\, P_{\epsilon,\ell\pm1}(r)\, dr \qquad (2)$$

in which r is the electron radial position in Bohr units, ϵ is the continuum (photo-ejected) electron energy, and $P_{n\ell}(r)$ and $P_{\epsilon,\ell\pm1}(r)$ are the bound and continuum radial wave functions, respectively, of the photoelectron. These wave functions P(r) were determined by solving the radial Schrödinger equation

$$\left[\frac{d^2}{dr^2} + V(r) + E_n - \frac{\ell(\ell+1)}{r^2}\right] P(r) = 0 \qquad (3)$$

in which E_n is the energy ($E_n<0$) in Rydbergs of an electron in the nth subshell. Values of the potential V(r) were taken from the tables of Herman and Skillman[11/] for both the Kaman and McGuire calculations.

The principal two points of difference between the Kaman and McGuire calculational procedures are in the treatments of V(r) and E_n in equation (3) for purposes of carrying out the necessary integrations for evaluating $P_{n\ell}(r)$ and $P_{\varepsilon,\ell\pm1}(r)$: (1) McGuire approximated the quantity rV(r) by a series of straight lines, by means of which solutions to equation (3) could be expressed analytically in terms of Whittaker functions and evaluated without recourse to numerical integration. In the Kaman calculation the tabulated Herman-Skillman[11/] V(r) values were used directly, and numerical integration was used. (2) McGuire used theoretical E_n values in equation (3) corresponding to the initial bound-state configuration, hence the frozen-orbital or unrelaxed-core approximation. In the Kaman calculation, on the other hand, core-relaxation or fast-rearrangement was taken into account to some extent by inserting experimental absorption-edge energies for E_n in equation (3).

Use of experimental E_n values has some advantage in providing absorption edges at the right energies, with no scaling of the calculated results required to relate them to experimental cross sections. There is, however, some risk in this procedure in that corrections may be inconsistently introduced, according to Pratt, Ron and Tseng.[12/] Pratt et al[12/] also suggest, on the basis of results of Rosen and Lindgren,[13/] that the relaxed-core (sudden rearrangement) approximation is more suitable for inner shells, particularly for light and medium Z elements, where binding energies calculated in this approximation agree best with experimental thresholds. However, for outer electron shells, binding energies calculated using the unrelaxed core (slow rearrangement) approximation tend to agree better with experimental thresholds.

III. Results

The McGuire energy grid is in integral values of angstroms rather than keV, and the upper energy varies from 0.310 keV (40 Å) for helium (Z=2) up to 62.0 keV (0.2Å) for silver (Z=47) through xenon (Z=54). Because of this varying upper energy, and also because McGuire gives no cross section values at the absorption edge energies, we interpolated (log-log linear interpolation) the Kaman photoeffect values to the McGuire energy grid for purposes of this comparison, rather than vice-versa. These interpolated values are listed in barns/atom in the last column in Table II following the McGuire values in the same units as taken from reference (9).

The results of the comparison are given in the second column of Table II. For each element Z = 2 to 54, the percentage deviation of the McGuire photoeffect cross sections from the Kaman values was calculated as

$$\text{Percent Deviation} = 100.0\ (\tau_{\text{McGuire}} - \tau_{\text{Kaman}})/\tau_{\text{Kaman}} \qquad (4)$$

The resulting sign indicates that the McGuire cross section is greater (+) or less (-) than the Kaman value. The percent deviations are rounded off to the nearest one-tenth percent.

In Figures 1 and 2 we have indicated the combinations of energy and atomic number for which the absolute deviation of the McGuire photoeffect cross section from the Kaman value exceeds 3% and 20%, respectively. It is evident from Figures 1 and 2 and an inspection of Table II that the majority of the deviations are between 3% and 20%. The only systematic trends appear to be that the McGuire values are generally greater than the Kaman values below 0.5 keV and tend to be less than the Kaman values in the region 1.0 to 10 keV.

In Figures 3, 4 and 5 we graphically compare the McGuire (dashed line) and Kaman (solid line) calculated results, also the Kaman values above 1.0 keV fitted to experimental data (dotted line) for carbon, aluminum and tin. Also included in these graphs are experimental total cross section data points from the NBS data-file indexed and documented in reference (14). In the regions shown, the total cross section on this scale is indistinguishable from the photoeffect, as was indicated in Table I. In Figure 4 the dip in the McGuire values at 2.07 keV for aluminum we attribute to a typographical error.

In these sample graphical comparisons we see that both the McGuire and Kaman results are for the most part consistent with the experimental data points within the experimental spread of the order of ± 20% . An exception to the ± 20% consistency is seen in Figure 5 for tin below 0.3 keV where a pronounced resonance-type feature is shown by the experimental points. Similar peaks have been observed between 0.1 and 1.0 keV for a number of other medium and high Z elements (see, e.g., Figs. 27-52 of reference (2), Vol. II). Although both the McGuire and Kaman calculated results tend to suggest the presence of such features, these cross section values may disagree with each other and/or with experiment by an order of magnitude at the peak energy.

Some additional isolated large discrepancies between the McGuire and Kaman values (1057% for nitrogen 0.103 keV and 640% for palladium at 6.2 keV) we attribute to misplaced decimal points in the McGuire tables. Other large discrepancies as listed in Table III we attribute to differences between the McGuire theoretical (initial bound-state configuration E_n values as discussed in Section II) absorption-edge energies and the experimental values from Bearden and Burr[15/] used in the Kaman calculations. All of these differences are positive, hence the theoretical McGuire threshold energy in each case in less than the Bearden-Burr value also listed in Table III.

References

1. G. L. Simmons and J. H. Hubbell: "Comparisons of Photon Interaction Cross Section Data Sets. I. Storm-Israel and ENDF/B; II. Biggs-Lighthill and ENDF/B; III. NSRDS-NBS 29 and ENDF/B; IV. Kaman and ENDF/B; V. Photran and ENDF/B," NBS Reports 10668, 10818, 10842, 10847 and 10848 (unpublished).

2. W. J. Veigele, E. Briggs, L. Bates, E. M. Henry and B. Bracewell (Kaman Nuclear Corp., Colorado Springs): "X-Ray Cross Section Compilation from 0.1 keV to 1 MeV," Vols. 1 and 2, Rev. 1, KN-71-431 (R) (DASA 2433) July 31, 1971.

3. E. M. Henry, C. L. Bates and W. J. Veigele: "Low-Energy Photoionization," Phys. Rev. A 6, 2131-2138 (1972).

4. The present ENDF/B photon interaction cross section library tape, also designated as RSIC (Radiation Shielding Information Center, Oak Ridge National Laboratory) tape DLC-7, became a part of the Evaluated Nuclear Data File system as a result of action taken by the Shielding Subcommittee of CSEWG (Cross Section Evaluation Working Group, AEC) at a meeting at Los Alamos May 12-13, 1970. This library is documented in references 5, 6 and 7 as discussed in reference 1 (I).

5. E. F. Plechaty and J. R. Terrall (Lawrence Livermore Lab., Calif.): "Photon Cross Sections 1 keV to 100 MeV", UCRL-50400, Vol. VI (1968).

6. W. H. McMaster, N. K. DelGrande and J. H. Mallett (Lawrence Livermore Lab., Calif.) and J. H. Hubbell (National Bureau of Standards): "Compilation of X-Ray Cross Sections", UCRL-50174, Sec. I (1970), Sec. II, Rev. 1 (1969), Sec. III (1969) and Sec. IV (1969). These reports are available from the National Technical Information Service, Springfield, Virginia 22151.

7. J. H. Hubbell: "Photon Cross Sections, Attenuation Coefficients, and Energy Absorption Coefficients from 10 keV to 100 GeV", NSRDS-NBS 29 (1969).

8. B. L. Henke and R. L. Elgin: "X-Ray Absorption Tables for the 2-to-200 Å Region," Adv. in X-Ray Anal. 13, 639-665 (1970).

9. E. J. McGuire: "Photo-Ionization Cross Sections of the Elements Helium to Xenon," Phys. Rev. 175, 20-30 (1968).

10. J. W. Cooper: "Photoionization from Outer Atomic Subshells. A Model Study," Phys. Rev. 128, 681-693 (1962).

11. F. Herman and S. Skillman: Atomic Structure Calculations (Prentice-Hall, Inc., Englewood Cliffs, N. J., 1963).

12. R. H. Pratt, A. Ron and H. K. Tseng: "Atomic Photoeffect above 10 keV," Rev. Mod. Phys. (in press).

13. A. Rosén and I. Lindgren: "Relativistic Calculations of Electron Binding Energies by a Modified Hartree-Fock-Slater Method," Phys. Rev. 176, 114-125 (1968).

14. J. H. Hubbell: "Survey of Photon-Attenuation-Coefficient Measurements 10 eV to 100 GeV," Atomic Data 3, 241-297 (1971).

15. J. A. Bearden and A. F. Burr: "Reevaluation of X-Ray Atomic Energy Levels," Rev. Mod. Phys. 39, 125-142 (1967); also in J. A. Bearden: "X-Ray Wavelengths and X-Ray Atomic Energy Levels," NSRDS-NBS 14 (1967).

Figure Captions

Figure 1. Elements and grid-energies (see Table II) for which the McGuire calculated photoeffect cross section is at least 3% greater (+) or less (-) than the corresponding photoeffect cross section interpolated from the Kaman data set. No McGuire values are given for higher energies or Z's beyond the indicated boundary line in Figures 1 and 2.

Figure 2. Elements and grid-energies for which the McGuire calculated photoeffect cross section is at least 20% greater (+) or less (-) than the corresponding photoeffect cross section interpolated from the Kaman data set.

Figure 3. Photoeffect cross sections for carbon calculated by McGuire (----) and Kaman (——), also fitted by Kaman to experimental data (.....). The circles are measured total-cross-section data-points (see text).

Figure 4. Photoeffect cross sections for aluminum, with same notation as Fig. 3.

Figure 5. Photoeffect cross sections for tin, with same notation as Fig. 3.

Table Captions

Table I. Ratios of the photoeffect cross section to the total cross section, based on values from the Kaman data set.[27]

Table II. Percent differences $100 \times (\tau_{McGuire} - \tau_{Kaman})/\tau_{Kaman}$ at the McGuire grid energies. The photoeffect cross sections $\tau_{McGuire}$ and τ_{Kaman} (interpolated to the McGuire energies) are listed in the last two columns in barns/atom.

Table III. Large percent differences in Table II attributable to discrepancies between the McGuire theoretical edge-energies and the Kaman experimental edge-energies. The experimental edge-energies or ranges of edge-energies, in the last three columns are taken from Bearden and Burr.[15]

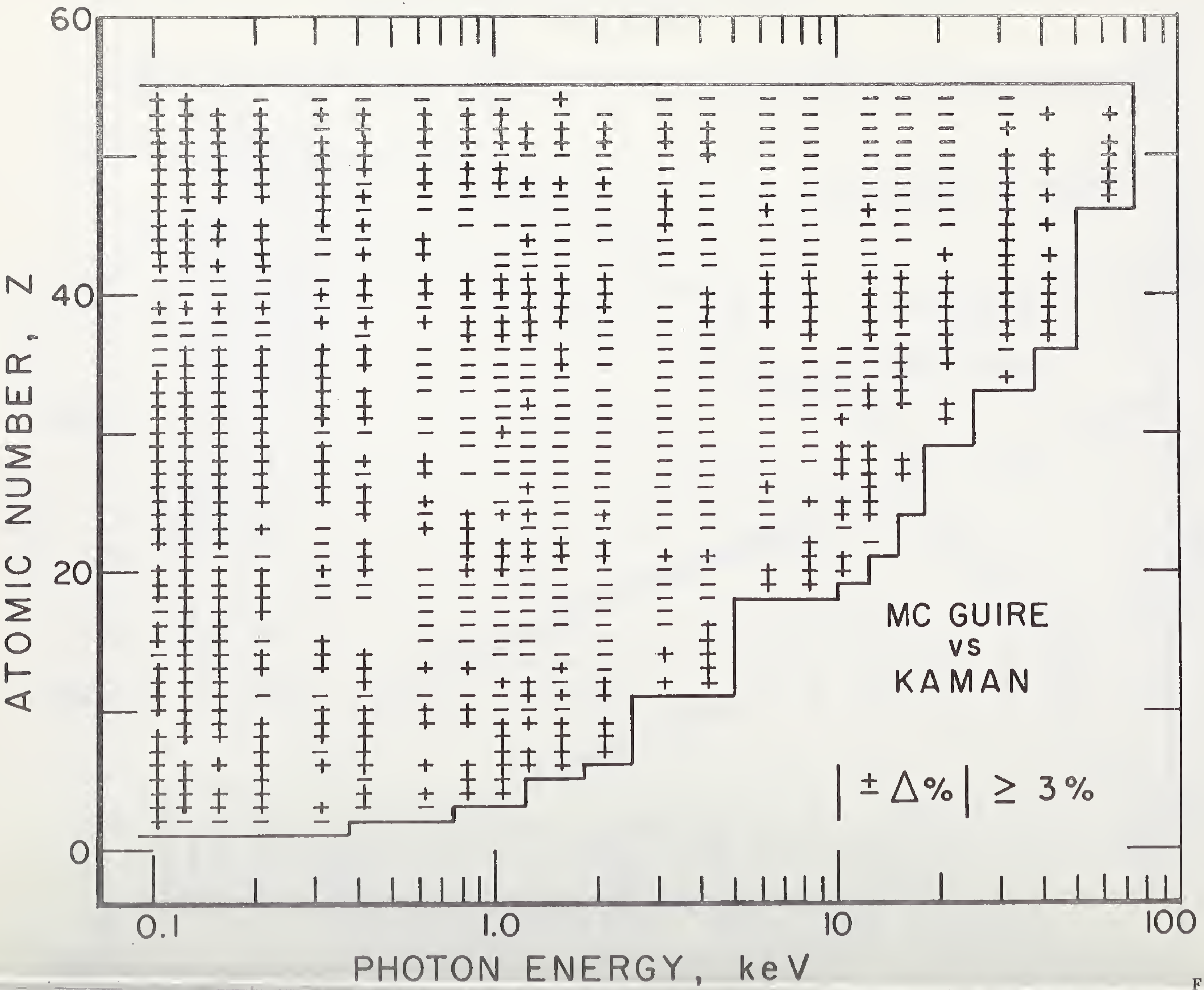

ATOMIC NUMBER, Z
0
20
40
60
0.1
1.0
10
100
PHOTON ENERGY, keV
MC GUIRE
vs
KAMAN
| ± Δ% | ≥ 3%

Fig. 1

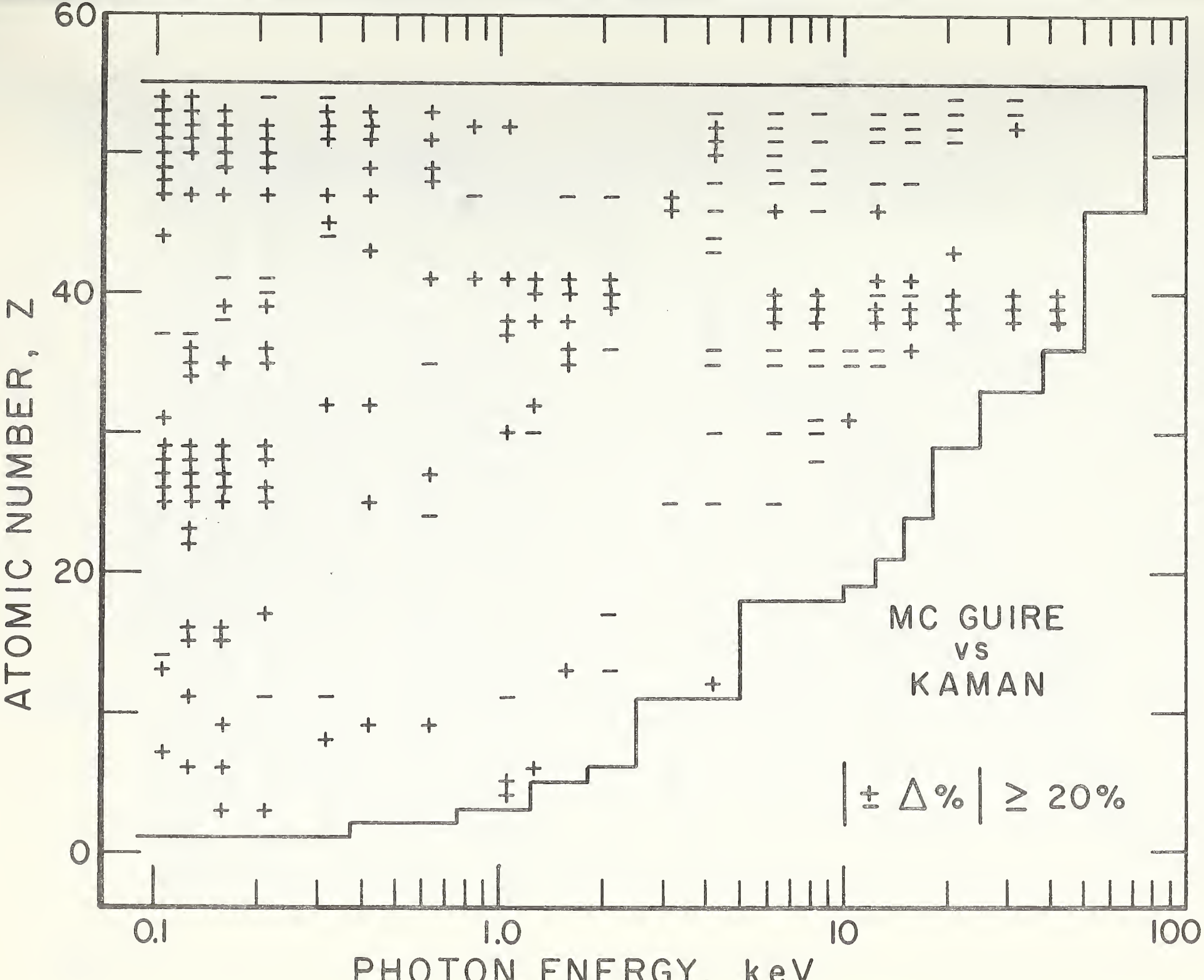
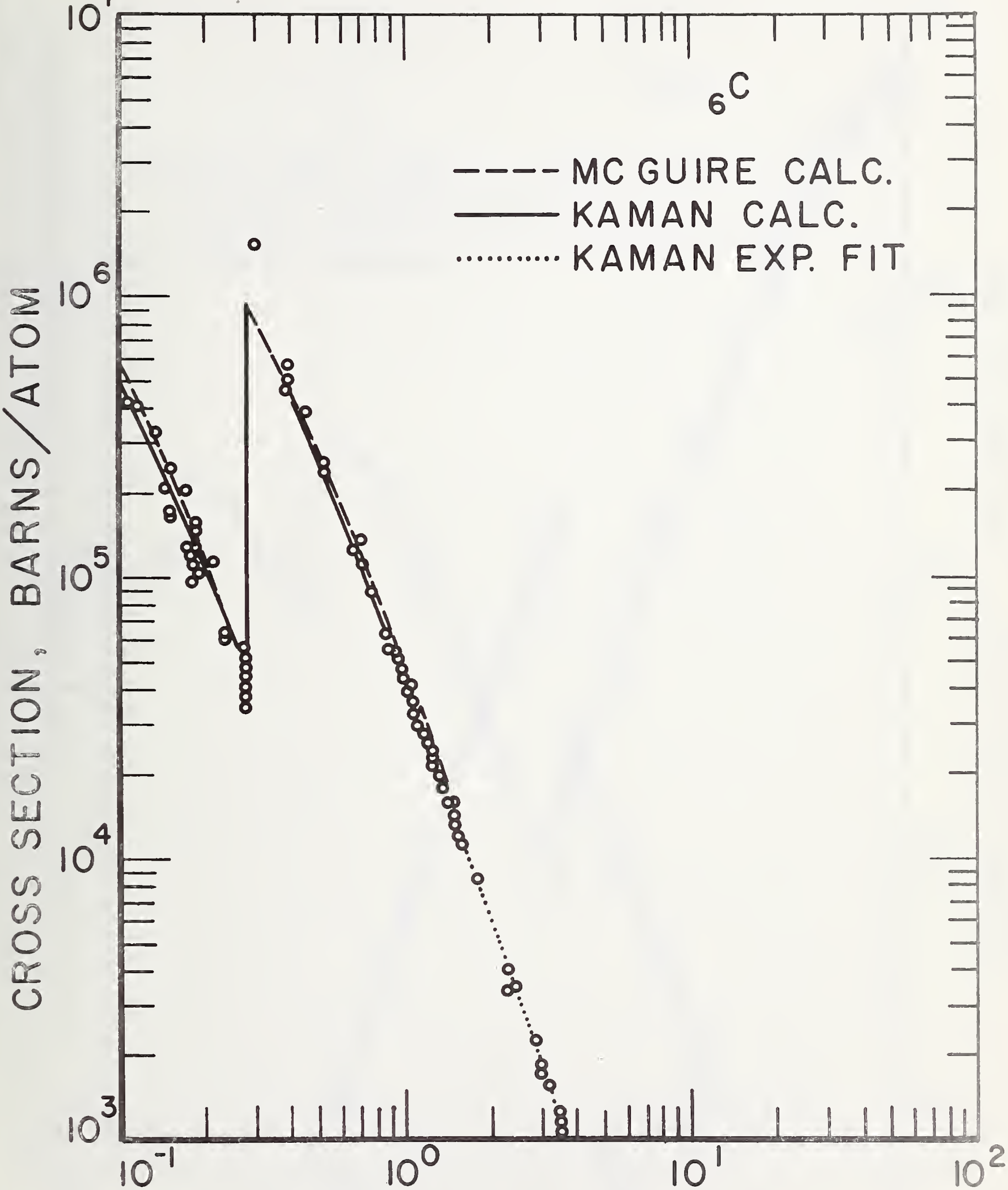
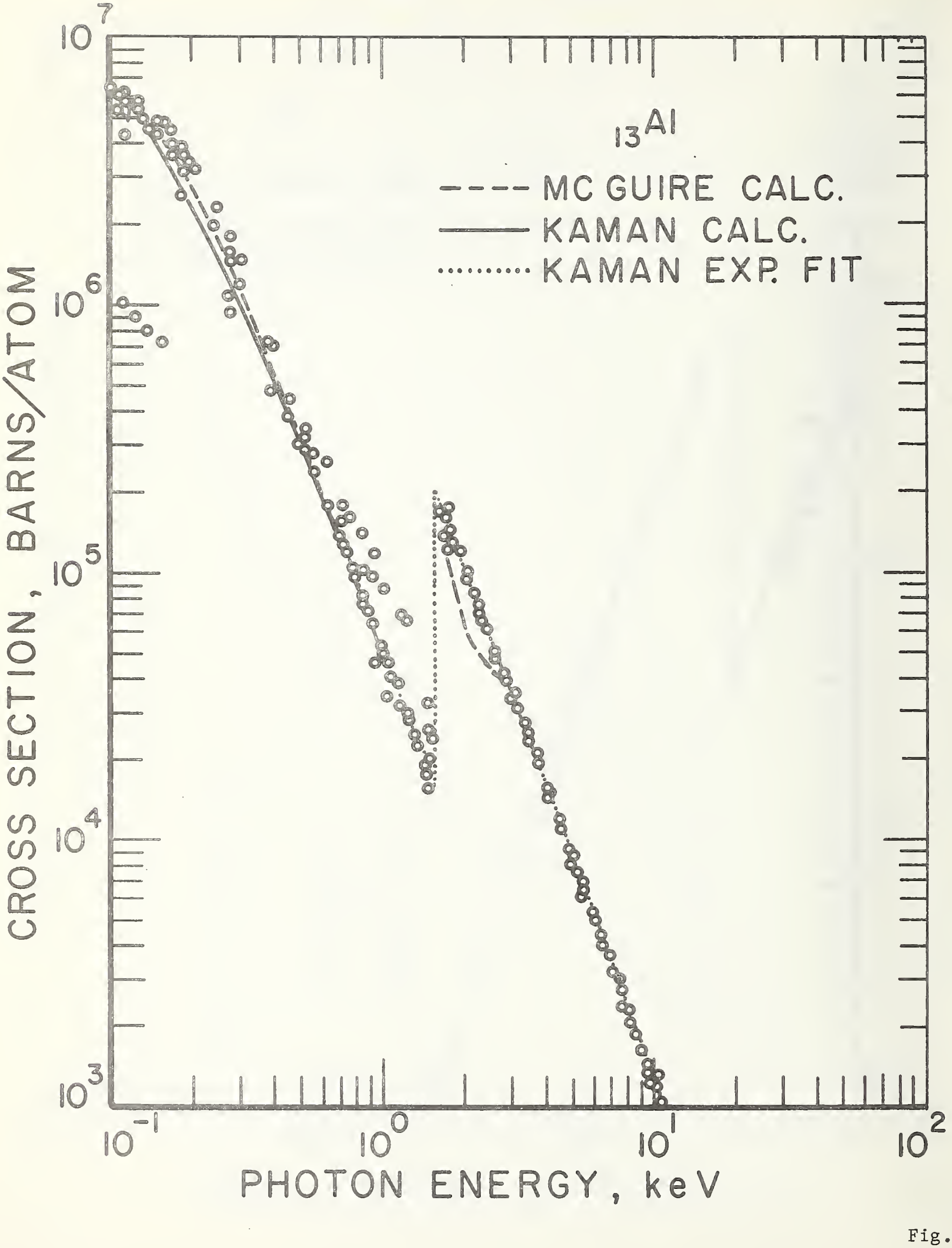

60
40
20
0
ATOMIC NUMBER, Z
0.1
1.0
10
100
PHOTON ENERGY, keV
MC GUIRE
vs
KAMAN
|± Δ%| ≥ 20%

Fig. 2



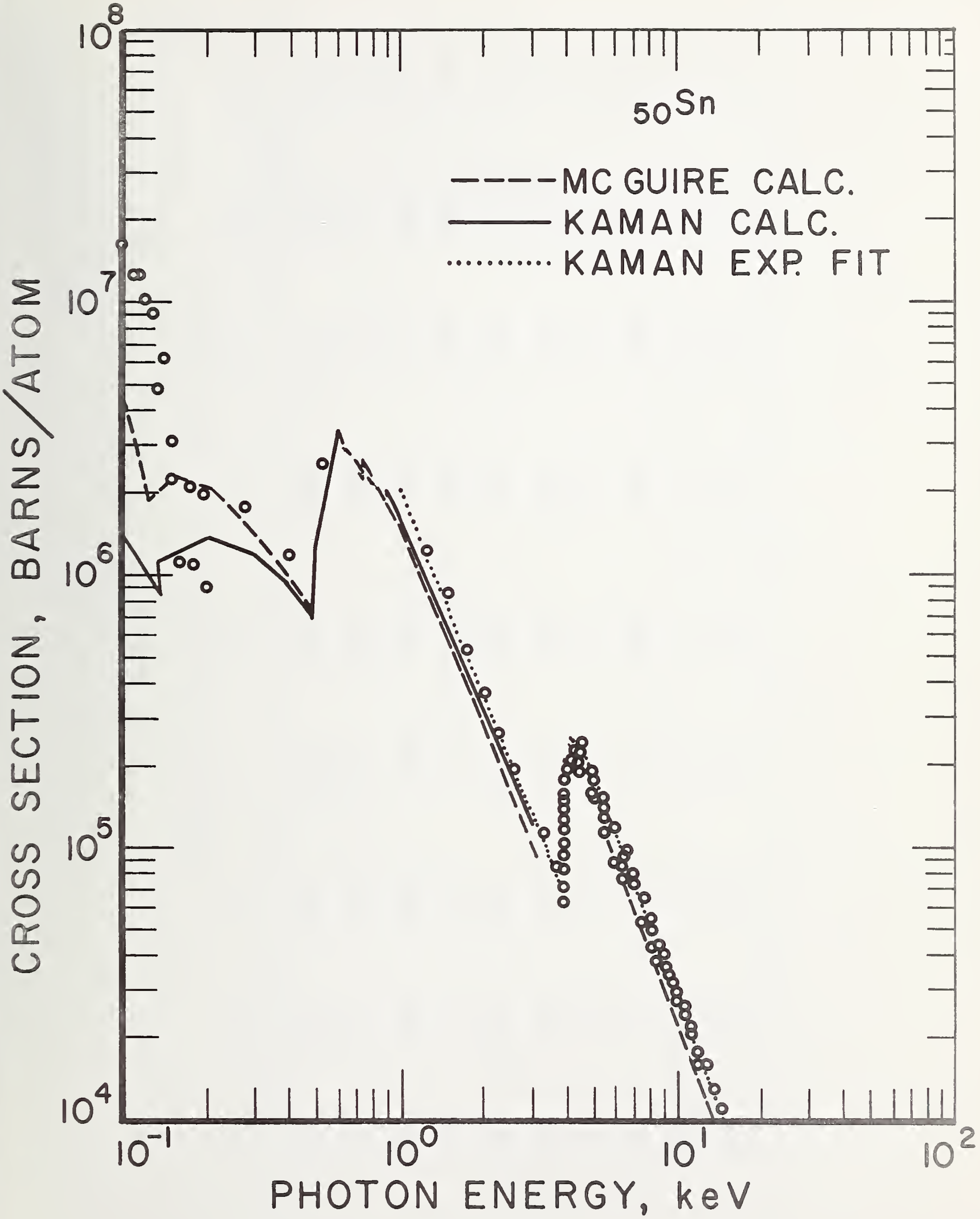
$_6$C
MC GUIRE CALC.
KAMAN CALC.
KAMAN EXP. FIT
CROSS SECTION, BARNS/ATOM
10^7
10^6
10^5
10^4
10^3
10^{-1}
10^0
10^1
10^2
PHOTON ENERGY, keV

Fig. 3



$_{13}$Al
MC GUIRE CALC.
KAMAN CALC.
KAMAN EXP. FIT
CROSS SECTION, BARNS/ATOM
PHOTON ENERGY, keV
10^7
10^6
10^5
10^4
10^3
10^{-1}
10^0
10^1
10^2

Fig. 4



$_{50}$Sn
MC GUIRE CALC.
KAMAN CALC.
KAMAN EXP. FIT
CROSS SECTION, BARNS/ATOM
PHOTON ENERGY, keV
10^8
10^7
10^6
10^5
10^4
10^{-1}
10^0
10^1
10^2

Fig. 5

Table I

E(keV)	(photoeffect cross section)/(total cross section)									
	${}_{1}H$	${}_{2}He$	${}_{3}Li$	${}_{6}C$	${}_{13}Al$	${}_{29}Cu$	${}_{50}Sn$	${}_{74}W$	${}_{82}Pb$	${}_{94}Pu$
0.1	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9988	0.9990	0.9985	0.9993
0.2	.9997	1.0000	1.0000	1.0000	1.0000	.9998	.9988	.9994	.9970	.9924
0.5	.9942	.9993	.9997	.9999	.9996	.9992	.9987	.9990	.9990	.9972
1.0	.9423	.9936	.9981	.9995	.9980	.9995	.9990	.9971	.9978	.9980
2.0	.6260	.9464	.9867	.9970	.9992	.9979	.9959	.9976	.9916	.9943
5.0	.0699	.5197	.8350	.9748	.9939	.9846	.9949	.9871	.9895	.9916
10.	.0071	.1150	.3892	.8704	.9744	.9958	.9818	.9535	.9632	.9720
20.	.0007	.0139	.0688	.4881	.9020	.9776	.9409	.9704	.9740	.9646
50.	< .0001	.0007	.0039	.0567	.4655	.8926	.9624	.8889	.9114	.9272
100.	< .0001	.0001	.0004	.0071	.1092	.6234	.8738	.9343	.9427	.8337

Table II

HELIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	3.1	3.40E+05	3.30E+05
.124	-12.4	1.80E+05	2.06E+05
.155	-12.8	1.00E+05	1.15E+05
.207	-11.7	4.60E+04	5.21E+04
.310	-7.6	1.50E+04	1.62E+04

LITHIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.8	1.52E+06	1.28E+06
.124	18.4	9.80E+05	8.27E+05
.155	20.1	5.80E+05	4.83E+05
.207	22.8	2.85E+05	2.32E+05
.310	13.0	8.90E+04	7.88E+04
.413	7.8	3.80E+04	3.52E+04
.620	-9.0	1.00E+04	1.10E+04

BERYLLIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	16.3	1.30E+05	1.12E+05
.124	14.2	2.16E+06	1.89E+06
.155	12.7	1.33E+06	1.18E+06
.207	8.3	6.70E+05	6.18E+05
.310	-2.1	2.20E+05	2.25E+05
.413	11.4	1.18E+05	1.06E+05
.620	15.3	4.00E+04	3.47E+04
.827	18.6	1.80E+04	1.52E+04
1.033	23.6	1.00E+04	8.09E+03

BORON

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	16.2	2.90E+05	2.50E+05
.124	10.3	1.85E+05	1.68E+05
.155	2.4	1.05E+05	1.03E+05
.207	17.7	1.32E+06	1.12E+06
.310	.6	4.80E+05	4.77E+05
.413	-6.2	2.20E+05	2.35E+05
.620	-.9	8.00E+04	8.07E+04
.827	3.6	3.80E+04	3.67E+04
1.033	27.1	2.50E+04	1.97E+04

Table II. Continued

CARBON

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	19.9	5.90E+05	4.92E+05
.124	21.9	4.00E+05	3.28E+05
.155	20.3	2.40E+05	1.99E+05
.207	4.5	1.08E+05	1.03E+05
.310	3.7	8.10E+05	7.81E+05
.413	6.3	4.50E+05	4.23E+05
.620	17.7	1.82E+05	1.55E+05
.827	17.9	8.50E+04	7.21E+04
1.033	19.4	4.70E+04	3.94E+04
1.240	20.8	2.90E+04	2.40E+04
1.550	19.5	1.50E+04	1.25E+04

NITROGEN

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	1056.5	1.11E+07	9.60E+05
.124	2.7	6.50E+05	6.33E+05
.155	2.7	3.90E+05	3.80E+05
.207	7.2	2.08E+05	1.94E+05
.310	-4.6	7.00E+04	7.34E+04
.413	3.8	6.80E+05	6.55E+05
.620	-2.8	2.55E+05	2.62E+05
.827	-.7	1.25E+05	1.26E+05
1.033	7.0	7.50E+04	7.01E+04
1.240	6.9	4.70E+04	4.40E+04
1.550	11.7	2.60E+04	2.33E+04
2.066	18.8	1.20E+04	1.01E+04

OXYGEN

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	14.9	1.77E+06	1.54E+06
.124	8.4	1.12E+06	1.03E+06
.155	10.8	7.00E+05	6.32E+05
.207	18.3	3.85E+05	3.25E+05
.310	30.3	1.60E+05	1.23E+05
.413	6.7	6.50E+04	6.09E+04
.620	.8	3.95E+05	3.92E+05
.827	.4	1.95E+05	1.94E+05
1.033	8.6	1.20E+05	1.11E+05
1.240	2.1	7.20E+04	7.05E+04
1.550	7.6	4.10E+04	3.81E+04
2.066	18.4	2.00E+04	1.69E+04

Table II. Continued

```
                                  FLUORINE
ENERGY   PERCENT
 (KEV)  DIFFERENCE                   MCGUIRE          KAMAN
  .103       2.3                    2.60E+06        2.54E+06
  .124       4.9                    1.80E+06        1.72E+06
  .155      23.0                    1.30E+06        1.06E+06
  .207       8.3                    5.90E+05        5.45E+05
  .310      19.4                    2.45E+05        2.05E+05
  .413      23.7                    1.24E+05        1.00E+05
  .620      39.8                    5.00E+04        3.58E+04
  .827       7.7                    3.05E+05        2.83E+05
 1.033       3.2                    1.70E+05        1.65E+05
 1.240       6.6                    1.15E+05        1.08E+05
 1.550      14.3                    6.70E+04        5.86E+04
 2.066      14.3                    3.00E+04        2.62E+04

                                  NEON
ENERGY   PERCENT
 (KEV)  DIFFERENCE                   MCGUIRE          KAMAN
  .103       3.5                    4.00E+06        3.86E+06
  .124       3.0                    2.80E+06        2.72E+06
  .155       3.3                    1.75E+06        1.69E+06
  .207       2.7                    9.10E+05        8.86E+05
  .310       7.6                    3.60E+05        3.35E+05
  .413       4.4                    1.70E+05        1.63E+05
  .620       9.7                    6.30E+04        5.74E+04
  .827      11.6                    3.00E+04        2.69E+04
 1.033     -13.6                    2.05E+05        2.37E+05
 1.240     -11.2                    1.35E+05        1.52E+05
 1.550      -8.3                    7.70E+04        8.40E+04
 2.066       1.7                    3.90E+04        3.83E+04

                                  SODIUM
ENERGY   PERCENT
 (KEV)  DIFFERENCE                   MCGUIRE          KAMAN
  .103      11.2                    4.95E+06        4.45E+06
  .124      24.0                    4.00E+06        3.23E+06
  .155      11.3                    2.40E+06        2.16E+06
  .207      -7.4                    1.10E+06        1.19E+06
  .310     -21.8                    3.70E+05        4.73E+05
  .413     -21.7                    1.86E+05        2.38E+05
  .620     -12.6                    7.50E+04        8.58E+04
  .827     -13.9                    3.50E+04        4.07E+04
 1.033     -21.2                    1.80E+04        2.28E+04
 1.240       8.0                    2.32E+05        2.15E+05
 1.550      15.9                    1.38E+05        1.19E+05
 2.066      11.7                    6.10E+04        5.46E+04
```

Table II. Continued

MAGNESIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	17.1	6.65E+06	5.68E+06
.124	12.2	4.80E+06	4.28E+06
.155	3.8	3.10E+06	2.99E+06
.207	-2.1	1.65E+06	1.69E+06
.310	-.6	6.80E+05	6.84E+05
.413	3.7	3.60E+05	3.47E+05
.620	-1.4	1.25E+05	1.27E+05
.827	-1.0	6.00E+04	6.06E+04
1.033	4.3	3.50E+04	3.36E+04
1.240	15.4	2.40E+04	2.08E+04
1.550	-3.8	1.52E+05	1.58E+05
2.066	7.0	7.90E+04	7.38E+04
3.100	12.9	2.75E+04	2.44E+04
4.133	23.9	1.34E+04	1.08E+04

ALUMINUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	22.6	6.48E+06	5.29E+06
.124	6.9	5.50E+06	5.15E+06
.155	11.0	4.13E+06	3.72E+06
.207	16.3	2.55E+06	2.19E+06
.310	13.5	1.05E+06	9.25E+05
.413	7.2	5.10E+05	4.76E+05
.620	4.7	1.85E+05	1.77E+05
.827	6.0	9.00E+04	8.49E+04
1.033	1.0	4.80E+04	4.75E+04
1.240	-10.2	2.65E+04	2.95E+04
1.550	962.0	1.70E+05	1.60E+04
2.066	-40.4	5.80E+04	9.74E+04
3.100	1.5	3.35E+04	3.30E+04
4.133	17.6	1.75E+04	1.49E+04

SILICON

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	-87.8	3.60E+05	2.95E+06
.124	10.7	5.24E+06	4.73E+06
.155	3.4	4.62E+06	4.47E+06
.207	10.1	3.10E+06	2.82E+06
.310	11.2	1.36E+06	1.22E+06
.413	6.7	6.80E+05	6.37E+05
.620	2.1	2.45E+05	2.40E+05
.827	-.9	1.15E+05	1.16E+05
1.033	-3.8	6.30E+04	6.55E+04
1.240	-9.4	3.75E+04	4.14E+04
1.550	-6.4	2.12E+04	2.27E+04
2.066	-15.8	1.08E+05	1.28E+05
3.100	3.3	4.45E+04	4.31E+04
4.133	5.7	2.05E+04	1.94E+04

Table II. Continued

PHOSPHORUS

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	15.4	5.70E+05	4.94E+05
.124	25.3	4.70E+05	3.75E+05
.155	21.0	5.40E+06	4.46E+06
.207	-3.4	3.46E+06	3.58E+06
.310	3.6	1.70E+06	1.64E+06
.413	-1.2	8.50E+05	8.60E+05
.620	-7.8	3.00E+05	3.26E+05
.827	-4.9	1.50E+05	1.58E+05
1.033	-10.0	8.00E+04	8.89E+04
1.240	-8.7	5.10E+04	5.58E+04
1.550	-.8	3.05E+04	3.07E+04
2.066	-12.2	1.25E+04	1.42E+04
3.100	.0	5.50E+04	5.50E+04
4.133	7.9	2.70E+04	2.50E+04

SULFUR

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.8	8.50E+05	7.16E+05
.124	25.1	7.00E+05	5.59E+05
.155	26.5	5.00E+05	3.95E+05
.207	-1.5	3.60E+06	3.65E+06
.310	-.6	2.05E+06	2.06E+06
.413	1.6	1.12E+06	1.10E+06
.620	-7.7	3.90E+05	4.23E+05
.827	-12.8	1.80E+05	2.07E+05
1.033	-14.4	1.00E+05	1.17E+05
1.240	-5.0	7.00E+04	7.37E+04
1.550	-6.3	3.80E+04	4.06E+04
2.066	-12.8	1.64E+04	1.88E+04
3.100	-2.9	6.70E+04	6.90E+04
4.133	7.6	3.40E+04	3.16E+04

CHLORINE

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	1.9	1.00E+06	9.81E+05
.124	3.9	8.20E+05	7.89E+05
.155	4.5	6.00E+05	5.74E+05
.207	129.0	6.40E+06	2.80E+06
.310	-1.6	2.45E+06	2.49E+06
.413	1.6	1.40E+06	1.38E+06
.620	-16.1	4.50E+05	5.37E+05
.827	-16.7	2.20E+05	2.64E+05
1.033	-18.2	1.23E+05	1.50E+05
1.240	-17.2	7.90E+04	9.54E+04
1.550	-10.9	4.70E+04	5.27E+04
2.066	-20.6	1.95E+04	2.46E+04
3.100	-11.9	7.50E+04	8.51E+04
4.133	-.8	3.90E+04	3.93E+04

Table II. Continued

ARGON

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	4.7	1.33E+06	1.27E+06
.124	4.9	1.10E+06	1.05E+06
.155	7.9	8.50E+05	7.88E+05
.207	9.5	5.50E+05	5.02E+05
.310	-9.4	2.52E+06	2.78E+06
.413	-5.9	1.66E+06	1.76E+06
.620	-10.4	6.20E+05	6.92E+05
.827	-14.9	2.90E+05	3.41E+05
1.033	-17.4	1.60E+05	1.94E+05
1.240	-18.3	1.00E+05	1.22E+05
1.550	-10.8	6.00E+04	6.72E+04
2.066	-16.3	2.60E+04	3.11E+04
3.100	-18.8	8.50E+03	1.05E+04
4.133	-7.1	4.60E+04	4.95E+04

POTASSIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	9.8	1.50E+06	1.37E+06
.124	13.8	1.30E+06	1.14E+06
.155	13.7	1.03E+06	9.06E+05
.207	13.4	6.80E+05	5.99E+05
.310	-7.7	3.30E+06	3.58E+06
.413	-7.1	1.92E+06	2.07E+06
.620	-12.9	7.30E+05	8.38E+05
.827	-4.4	4.00E+05	4.18E+05
1.033	-8.2	2.20E+05	2.40E+05
1.240	-14.8	1.30E+05	1.53E+05
1.550	-7.4	7.80E+04	8.42E+04
2.066	-13.2	3.40E+04	3.92E+04
3.100	-9.9	1.20E+04	1.33E+04
4.133	-7.3	5.40E+04	5.83E+04
6.199	3.7	2.00E+04	1.93E+04
8.265	5.7	9.10E+03	8.61E+03

Table II. Continued

CALCIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.8	1.80E+06	1.51E+06
.124	18.2	1.53E+06	1.29E+06
.155	10.1	1.16E+06	1.05E+06
.207	8.7	7.80E+05	7.17E+05
.310	16.5	4.30E+05	3.69E+05
.413	5.2	2.20E+06	2.09E+06
.620	-7.7	9.20E+05	9.97E+05
.827	-.6	5.00E+05	5.03E+05
1.033	3.4	3.00E+05	2.90E+05
1.240	-1.4	1.80E+05	1.82E+05
1.550	-4.3	9.80E+04	1.02E+05
2.066	-3.9	4.60E+04	4.78E+04
3.100	-8.5	1.50E+04	1.64E+04
4.133	-12.0	6.10E+04	6.93E+04
6.199	3.3	2.40E+04	2.32E+04
8.265	5.3	1.10E+04	1.04E+04
10.332	9.9	6.10E+03	5.55E+03

SCANDIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	1.6	1.95E+06	1.92E+06
.124	3.4	1.67E+06	1.62E+06
.155	-3.3	1.25E+06	1.29E+06
.207	-11.0	7.80E+05	8.76E+05
.310	-4.8	4.30E+05	4.52E+05
.413	13.0	2.50E+06	2.21E+06
.620	.3	1.20E+06	1.20E+06
.827	11.3	6.80E+05	6.11E+05
1.033	16.4	4.10E+05	3.52E+05
1.240	12.4	2.50E+05	2.23E+05
1.550	11.7	1.40E+05	1.25E+05
2.066	7.5	6.30E+04	5.86E+04
3.100	4.5	2.10E+04	2.01E+04
4.133	7.4	1.00E+04	9.31E+03
6.199	-2.5	2.70E+04	2.77E+04
8.265	7.6	1.35E+04	1.26E+04
10.332	10.5	7.40E+03	6.70E+03

Table II. Continued

CHROMIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	RAMAN
.103	14.4	4.15E+06	3.63E+06
.124	12.9	3.30E+06	2.92E+06
.155	7.8	2.40E+06	2.23E+06
.207	-.7	1.45E+06	1.46E+06
.310	-2.6	7.20E+05	7.39E+05
.413	4.6	4.50E+05	4.30E+05
.620	-88.2	2.00E+05	1.70E+06
.827	11.5	1.10E+06	9.86E+05
1.033	15.4	6.70E+05	5.81E+05
1.240	8.1	4.00E+05	3.70E+05
1.550	9.4	2.30E+05	2.10E+05
2.066	3.4	1.03E+05	9.97E+04
3.100	-3.0	3.30E+04	3.40E+04
4.133	-4.5	1.50E+04	1.57E+04
6.199	-11.0	4.00E+04	4.49E+04
8.265	1.4	2.10E+04	2.07E+04
10.332	5.5	1.18E+04	1.12E+04
12.398	7.4	7.20E+03	6.71E+03

MANGANESE

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	RAMAN
.103	37.5	5.45E+06	3.96E+06
.124	37.5	4.45E+06	3.24E+06
.155	32.0	3.30E+06	2.50E+06
.207	23.8	2.05E+06	1.66E+06
.310	15.7	9.80E+05	8.47E+05
.413	20.5	6.00E+05	4.98E+05
.620	13.9	2.50E+05	2.20E+05
.827	-.8	1.10E+06	1.11E+06
1.033	-9.2	6.00E+05	6.61E+05
1.240	-5.9	4.00E+05	4.25E+05
1.550	-13.7	2.10E+05	2.43E+05
2.066	-15.8	9.80E+04	1.16E+05
3.100	-22.8	3.10E+04	4.02E+04
4.133	-24.2	1.40E+04	1.85E+04
6.199	-25.6	4.60E+03	6.19E+03
8.265	7.9	2.55E+04	2.36E+04
10.332	9.4	1.40E+04	1.28E+04
12.398	5.3	8.10E+03	7.69E+03
15.498	-2.2	4.00E+03	4.09E+03

Table II. Continued

TITANIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	12.6	2.55E+06	2.26E+06
.124	23.3	2.32E+06	1.88E+06
.155	14.5	1.70E+06	1.48E+06
.207	1.4	1.02E+06	1.01E+06
.310	-8.4	4.80E+05	5.24E+05
.413	3.8	3.20E+05	3.08E+05
.620	1.3	1.40E+06	1.38E+06
.827	3.1	7.40E+05	7.17E+05
1.033	5.5	4.40E+05	4.17E+05
1.240	13.4	3.00E+05	2.65E+05
1.550	6.8	1.60E+05	1.50E+05
2.066	3.5	7.30E+04	7.06E+04
3.100	2.8	2.50E+04	2.43E+04
4.133	2.7	1.15E+04	1.12E+04
6.199	-1.2	3.20E+04	3.24E+04
8.265	3.8	1.55E+04	1.49E+04
10.332	-.6	8.00E+03	8.05E+03
12.398	-4.5	4.60E+03	4.82E+03

VANADIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.6	3.20E+06	2.70E+06
.124	21.7	2.70E+06	2.22E+06
.155	18.3	2.05E+06	1.73E+06
.207	4.5	1.22E+06	1.17E+06
.310	-9.6	5.50E+05	6.09E+05
.413	-2.7	3.50E+05	3.60E+05
.620	12.0	1.55E+06	1.38E+06
.827	-4.1	8.00E+05	8.34E+05
1.033	2.1	5.00E+05	4.90E+05
1.240	-3.8	3.00E+05	3.12E+05
1.550	-4.1	1.70E+05	1.77E+05
2.066	-2.1	8.20E+04	8.38E+04
3.100	-3.4	2.75E+04	2.85E+04
4.133	-5.9	1.23E+04	1.31E+04
6.199	-9.4	3.45E+04	3.81E+04
8.265	-2.8	1.70E+04	1.75E+04
10.332	-3.4	9.10E+03	9.42E+03
12.398	-2.5	5.50E+03	5.64E+03

Table II. Continued

IRON

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	28.8	6.00E+06	4.66E+06
.124	32.3	5.05E+06	3.82E+06
.155	31.7	3.90E+06	2.96E+06
.207	27.2	2.50E+06	1.97E+06
.310	9.8	1.10E+06	1.00E+06
.413	7.6	6.30E+05	5.86E+05
.620	1.2	2.60E+05	2.57E+05
.827	-.9	1.10E+06	1.11E+06
1.033	1.3	7.70E+05	7.60E+05
1.240	12.0	5.50E+05	4.91E+05
1.550	-4.3	2.70E+05	2.82E+05
2.066	-7.8	1.25E+05	1.36E+05
3.100	-6.7	4.40E+04	4.72E+04
4.133	-3.0	2.10E+04	2.16E+04
6.199	6.6	7.70E+03	7.22E+03
8.265	1.7	2.75E+04	2.70E+04
10.332	1.5	1.50E+04	1.48E+04
12.398	3.0	9.20E+03	8.93E+03
15.498	2.6	4.90E+03	4.78E+03

COBALT

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	29.3	6.80E+06	5.26E+06
.124	27.7	5.55E+06	4.35E+06
.155	20.3	4.10E+06	3.41E+06
.207	11.6	2.55E+06	2.29E+06
.310	7.1	1.25E+06	1.17E+06
.413	-4.8	6.50E+05	6.83E+05
.620	20.6	3.60E+05	2.99E+05
.827	-3.8	1.20E+06	1.25E+06
1.033	-10.7	7.70E+05	8.62E+05
1.240	-5.3	5.30E+05	5.60E+05
1.550	-4.1	3.10E+05	3.23E+05
2.066	-4.1	1.50E+05	1.56E+05
3.100	-14.1	4.70E+04	5.47E+04
4.133	-16.6	2.10E+04	2.52E+04
6.199	-15.7	7.10E+03	8.42E+03
8.265	-2.7	3.10E+04	3.19E+04
10.332	4.0	1.80E+04	1.73E+04
12.398	3.7	1.08E+04	1.04E+04
15.498	4.5	5.80E+03	5.55E+03

Table II. Continued

NICKEL

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	38.1	7.70E+06	5.58E+06
.124	35.2	6.75E+06	4.99E+06
.155	34.8	5.35E+06	3.97E+06
.207	27.8	3.40E+06	2.66E+06
.310	9.6	1.50E+06	1.37E+06
.413	6.5	8.50E+05	7.98E+05
.620	10.4	3.90E+05	3.53E+05
.827	1.5	1.90E+05	1.87E+05
1.033	-9.6	9.00E+05	9.95E+05
1.240	-6.2	6.00E+05	6.40E+05
1.550	-8.1	3.40E+05	3.70E+05
2.066	-11.0	1.60E+05	1.80E+05
3.100	-17.4	5.20E+04	6.29E+04
4.133	-13.3	2.50E+04	2.89E+04
6.199	-14.7	8.20E+03	9.61E+03
8.265	-20.5	3.50E+03	4.41E+03
10.332	9.8	2.07E+04	1.89E+04
12.398	8.4	1.25E+04	1.15E+04
15.498	4.1	6.50E+03	6.24E+03

COPPER

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	24.6	8.15E+06	6.54E+06
.124	26.1	7.15E+06	5.67E+06
.155	21.5	5.80E+06	4.77E+06
.207	28.8	4.00E+06	3.10E+06
.310	6.0	1.70E+06	1.60E+06
.413	.8	9.50E+05	9.42E+05
.620	2.9	4.30E+05	4.18E+05
.827	-7.1	2.10E+05	2.26E+05
1.033	-.8	1.00E+06	1.01E+06
1.240	-9.6	6.70E+05	7.41E+05
1.550	-8.3	3.90E+05	4.25E+05
2.066	-8.4	1.90E+05	2.08E+05
3.100	-8.8	6.50E+04	7.13E+04
4.133	-10.5	3.00E+04	3.35E+04
6.199	-10.7	1.00E+04	1.12E+04
8.265	-12.5	4.50E+03	5.14E+03
10.332	9.2	2.35E+04	2.15E+04
12.398	10.1	1.45E+04	1.32E+04
15.498	.8	7.20E+03	7.14E+03

Table II. Continued

ZINC

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.3	8.45E+06	7.14E+06
.124	15.8	7.05E+06	6.09E+06
.155	10.3	5.75E+06	5.21E+06
.207	4.0	3.80E+06	3.65E+06
.310	-3.7	1.85E+06	1.92E+06
.413	-5.1	1.07E+06	1.13E+06
.620	-8.9	4.40E+05	4.83E+05
.827	-18.2	2.10E+05	2.57E+05
1.033	109.3	1.06E+06	5.07E+05
1.240	-20.7	6.60E+05	8.32E+05
1.550	-13.0	4.20E+05	4.83E+05
2.066	-17.0	1.95E+05	2.35E+05
3.100	-8.1	7.50E+04	8.16E+04
4.133	-25.2	2.85E+04	3.81E+04
6.199	-26.9	9.40E+03	1.29E+04
8.265	-29.4	4.20E+03	5.95E+03
10.332	.9	2.50E+04	2.48E+04
12.398	2.3	1.55E+04	1.52E+04
15.498	1.1	8.30E+03	8.21E+03
20.663	-1.5	3.60E+03	3.65E+03

GALLIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	23.8	8.65E+06	6.99E+06
.124	16.2	7.55E+06	6.50E+06
.155	17.3	6.35E+06	5.41E+06
.207	19.2	4.90E+06	4.11E+06
.310	15.0	2.55E+06	2.22E+06
.413	7.4	1.40E+06	1.30E+06
.620	-7.4	5.20E+05	5.62E+05
.827	-6.4	2.80E+05	2.99E+05
1.033	-9.5	1.60E+05	1.77E+05
1.240	-4.6	7.80E+05	8.18E+05
1.550	-6.0	5.10E+05	5.42E+05
2.066	-13.3	2.30E+05	2.65E+05
3.100	-18.9	7.50E+04	9.24E+04
4.133	-16.0	3.60E+04	4.29E+04
6.199	-18.0	1.20E+04	1.46E+04
8.265	-21.1	5.30E+03	6.72E+03
10.332	634.4	2.70E+04	3.68E+03
12.398	1.8	1.70E+04	1.67E+04
15.498	2.4	9.30E+03	9.08E+03
20.663	3.4	4.20E+03	4.06E+03

Table II. Continued

GERMANIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	17.5	8.20E+06	6.98E+06
.124	13.8	7.85E+06	6.90E+06
.155	15.5	6.80E+06	5.89E+06
.207	19.8	5.50E+06	4.59E+06
.310	30.0	3.30E+06	2.54E+06
.413	39.7	2.10E+06	1.50E+06
.620	-2.1	6.40E+05	6.54E+05
.827	-2.1	3.40E+05	3.47E+05
1.033	-3.0	2.00E+05	2.06E+05
1.240	90.2	9.10E+05	4.79E+05
1.550	-5.0	5.80E+05	6.11E+05
2.066	-9.7	2.70E+05	2.99E+05
3.100	-19.1	8.50E+04	1.05E+05
4.133	-17.8	4.00E+04	4.87E+04
6.199	-17.7	1.35E+04	1.64E+04
8.265	-18.8	6.10E+03	7.51E+03
10.332	-19.4	3.30E+03	4.09E+03
12.398	4.3	1.90E+04	1.82E+04
15.498	6.4	1.06E+04	9.97E+03
20.663	4.6	4.70E+03	4.49E+03

ARSENIC

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.1	7.62E+06	6.45E+06
.124	17.5	7.40E+06	6.30E+06
.155	13.9	7.10E+06	6.23E+06
.207	12.0	5.70E+06	5.09E+06
.310	11.7	3.22E+06	2.88E+06
.413	9.1	1.88E+06	1.72E+06
.620	-10.0	6.80E+05	7.56E+05
.827	-7.7	3.70E+05	4.01E+05
1.033	-7.9	2.20E+05	2.39E+05
1.240	-6.7	1.45E+05	1.55E+05
1.550	-5.8	6.40E+05	6.79E+05
2.066	-4.6	3.20E+05	3.35E+05
3.100	-7.1	1.10E+05	1.18E+05
4.133	-11.1	4.90E+04	5.51E+04
6.199	-9.5	1.70E+04	1.88E+04
8.265	-10.6	7.70E+03	8.61E+03
10.332	-17.2	3.90E+03	4.71E+03
12.398	10.1	2.30E+04	2.09E+04
15.498	3.4	1.18E+04	1.14E+04
20.663	-2.8	5.00E+03	5.14E+03

Table II. Continued

SELENIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	11.5	6.00E+06	5.38E+06
.124	29.5	7.50E+06	5.79E+06
.155	15.8	7.10E+06	6.13E+06
.207	17.0	6.25E+06	5.34E+06
.310	8.0	3.55E+06	3.29E+06
.413	.8	2.00E+06	1.98E+06
.620	-14.3	7.50E+05	8.75E+05
.827	-13.8	4.00E+05	4.64E+05
1.033	-11.6	2.45E+05	2.77E+05
1.240	-16.3	1.50E+05	1.79E+05
1.550	-8.7	6.00E+05	6.57E+05
2.066	1.0	3.80E+05	3.76E+05
3.100	-13.8	1.15E+05	1.33E+05
4.133	-16.5	5.20E+04	6.23E+04
6.199	-15.1	1.80E+04	2.12E+04
8.265	-13.8	8.40E+03	9.74E+03
10.332	-13.6	4.60E+03	5.33E+03
12.398	-17.0	2.70E+03	3.25E+03
15.498	6.9	1.37E+04	1.28E+04
20.663	.1	5.80E+03	5.80E+03
30.995	3.4	1.90E+03	1.84E+03

BROMINE

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	-19.6	3.00E+06	3.73E+06
.124	36.0	6.40E+06	4.71E+06
.155	30.7	7.75E+06	5.93E+06
.207	31.6	7.35E+06	5.59E+06
.310	13.7	4.10E+06	3.60E+06
.413	3.8	2.30E+06	2.22E+06
.620	-21.2	7.80E+05	9.89E+05
.827	-12.8	4.60E+05	5.28E+05
1.033	-9.9	2.85E+05	3.16E+05
1.240	-10.0	1.85E+05	2.05E+05
1.550	416.3	6.20E+05	1.20E+05
2.066	-10.4	3.75E+05	4.18E+05
3.100	-19.6	1.20E+05	1.49E+05
4.133	-22.7	5.40E+04	6.98E+04
6.199	-22.1	1.85E+04	2.39E+04
8.265	-21.9	8.50E+03	1.09E+04
10.332	-24.2	4.50E+03	5.94E+03
12.398	-25.4	2.70E+03	3.62E+03
15.498	16.8	1.65E+04	1.41E+04
20.663	7.6	5.90E+03	6.41E+03
30.995	-2.1	2.00E+03	2.04E+03

Table II. Continued

KRYPTON

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	-6.7	1.20E+06	1.29E+06
.124	31.7	3.40E+06	2.58E+06
.155	13.7	6.10E+06	5.37E+06
.207	25.9	6.80E+06	5.40E+06
.310	6.7	4.40E+06	4.12E+06
.413	3.2	2.65E+06	2.57E+06
.620	-17.6	9.50E+05	1.15E+06
.827	-12.2	5.40E+05	6.15E+05
1.033	-7.9	3.40E+05	3.69E+05
1.240	-8.3	2.20E+05	2.40E+05
1.550	401.4	7.00E+05	1.40E+05
2.066	-21.1	4.10E+05	5.20E+05
3.100	-19.4	1.40E+05	1.74E+05
4.133	-23.5	6.10E+04	7.98E+04
6.199	-25.0	2.00E+04	2.67E+04
8.265	-21.6	9.60E+03	1.22E+04
10.332	-20.8	5.30E+03	6.70E+03
12.398	-21.8	3.20E+03	4.09E+03
15.498	32.2	2.05E+04	1.55E+04
20.663	11.6	7.90E+03	7.08E+03
30.995	-3.2	2.20E+03	2.27E+03

RUBIDIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	-45.6	2.50E+05	4.60E+05
.124	-31.5	1.00E+06	1.46E+06
.155	-8.3	3.90E+06	4.25E+06
.207	-10.0	4.80E+06	5.33E+06
.310	2.9	4.30E+06	4.18E+06
.413	-5.1	2.65E+06	2.79E+06
.620	-1.7	1.25E+06	1.27E+06
.827	12.1	7.70E+05	6.87E+05
1.033	21.3	5.00E+05	4.12E+05
1.240	11.1	3.00E+05	2.70E+05
1.550	1.7	1.60E+05	1.57E+05
2.066	-19.5	4.80E+05	5.96E+05
3.100	-18.7	1.60E+05	1.97E+05
4.133	-10.8	8.00E+04	8.96E+04
6.199	-2.0	2.90E+04	2.96E+04
8.265	3.9	1.40E+04	1.35E+04
12.398	10.2	4.90E+03	4.45E+03
15.498	-5.9	1.60E+04	1.70E+04
20.663	12.8	8.80E+03	7.80E+03
30.995	7.3	2.70E+03	2.52E+03
41.327	4.0	1.15E+03	1.11E+03

Table II. Continued

STRONTIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	-6.7	5.10E+05	5.47E+05
.124	-3.7	4.70E+05	4.88E+05
.155	-83.3	3.90E+05	2.33E+06
.207	-14.8	4.30E+06	5.05E+06
.310	13.3	5.00E+06	4.41E+06
.413	12.0	3.40E+06	3.04E+06
.620	13.4	1.60E+06	1.41E+06
.827	17.3	9.00E+05	7.67E+05
1.033	23.0	5.70E+05	4.63E+05
1.240	31.7	4.00E+05	3.04E+05
1.550	49.1	2.65E+05	1.78E+05
2.066	-15.1	4.70E+05	5.54E+05
3.100	-4.2	2.10E+05	2.19E+05
4.133	5.1	1.05E+05	9.99E+04
6.199	33.6	4.40E+04	3.29E+04
8.265	53.4	2.30E+04	1.50E+04
12.398	100.0	9.90E+03	4.95E+03
15.498	108.3	5.60E+03	2.69E+03
20.663	36.0	1.17E+04	8.60E+03
30.995	25.6	3.50E+03	2.79E+03
41.327	22.2	1.50E+03	1.23E+03

YTTRIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.3	7.60E+05	6.42E+05
.124	16.7	6.80E+05	5.83E+05
.155	444.8	2.80E+06	5.14E+05
.207	50.9	6.90E+06	4.57E+06
.310	-6.0	4.40E+06	4.68E+06
.413	-3.0	3.25E+06	3.35E+06
.620	-5.0	1.50E+06	1.58E+06
.827	-3.6	8.30E+05	8.61E+05
1.033	-4.1	5.00E+05	5.22E+05
1.240	17.0	4.00E+05	3.42E+05
1.550	17.3	2.35E+05	2.00E+05
2.066	42.7	1.40E+05	9.81E+04
3.100	-9.7	2.20E+05	2.44E+05
4.133	3.7	1.15E+05	1.11E+05
6.199	23.0	4.50E+04	3.66E+04
8.265	44.1	2.40E+04	1.67E+04
12.398	82.0	1.00E+04	5.49E+03
15.498	104.5	6.10E+03	2.98E+03
20.663	26.8	1.20E+04	9.46E+03
30.995	33.2	4.10E+03	3.08E+03
41.327	58.3	2.15E+03	1.36E+03

Table II. Continued

ZIRCONIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	.8	7.20E+05	7.14E+05
.124	-5.5	6.30E+05	6.67E+05
.155	-14.2	5.20E+05	6.06E+05
.207	-74.5	7.00E+05	2.75E+06
.310	19.2	5.10E+06	4.28E+06
.413	14.8	3.95E+06	3.44E+06
.620	14.7	2.00E+06	1.74E+06
.827	10.9	1.06E+06	9.56E+05
1.033	16.9	6.80E+05	5.82E+05
1.240	25.7	4.80E+05	3.82E+05
1.550	38.1	3.10E+05	2.24E+05
2.066	61.7	1.80E+05	1.11E+05
3.100	-.9	2.70E+05	2.73E+05
4.133	9.3	1.35E+05	1.24E+05
6.199	23.4	5.00E+04	4.05E+04
8.265	36.2	2.50E+04	1.84E+04
12.398	66.1	1.00E+04	6.02E+03
15.498	81.1	5.90E+03	3.26E+03
20.663	29.5	1.30E+04	1.00E+04
30.995	25.1	4.20E+03	3.36E+03
41.327	33.3	2.00E+03	1.50E+03

NIOBIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	-8.6	7.10E+05	7.77E+05
.124	-14.3	6.50E+05	7.59E+05
.155	-24.2	5.50E+05	7.25E+05
.207	-54.6	3.90E+05	8.59E+05
.310	-10.0	4.10E+06	4.56E+06
.413	13.0	4.32E+06	3.82E+06
.620	22.2	2.40E+06	1.96E+06
.827	22.3	1.32E+06	1.08E+06
1.033	21.9	8.00E+05	6.56E+05
1.240	23.1	5.30E+05	4.31E+05
1.550	30.5	3.30E+05	2.53E+05
2.066	40.4	1.75E+05	1.25E+05
3.100	-1.2	3.00E+05	3.04E+05
4.133	-1.9	1.35E+05	1.32E+05
6.199	10.8	5.00E+04	4.51E+04
8.265	17.4	2.40E+04	2.04E+04
12.398	32.8	8.90E+03	6.70E+03
15.498	40.6	5.10E+03	3.63E+03
20.663	12.7	1.22E+04	1.08E+04
30.995	14.3	4.20E+03	3.67E+03
41.327	5.5	1.75E+03	1.66E+03

Table II. Continued

MOLYBDENUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	10.2	8.60E+05	7.98E+05
.124	11.8	9.00E+05	8.05E+05
.155	15.1	9.20E+05	7.99E+05
.207	16.7	8.00E+05	6.86E+05
.310	-2.8	4.42E+06	4.55E+06
.413	2.9	4.04E+06	3.93E+06
.620	-.1	2.13E+06	2.13E+06
.827	-2.6	1.15E+06	1.18E+06
1.033	-3.0	7.00E+05	7.22E+05
1.240	-3.2	4.60E+05	4.75E+05
1.550	-10.6	2.50E+05	2.80E+05
2.066	-10.2	1.25E+05	1.39E+05
3.100	-16.6	2.80E+05	3.36E+05
4.133	-17.5	1.25E+05	1.52E+05
6.199	-17.1	4.10E+04	4.94E+04
8.265	-14.9	1.90E+04	2.23E+04
12.398	-9.4	6.60E+03	7.28E+03
15.498	-5.9	3.70E+03	3.93E+03
20.663	.3	1.20E+04	1.20E+04
30.995	4.0	4.20E+03	4.04E+03
41.327	1.6	1.95E+03	1.92E+03

TECHNETIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	18.0	1.04E+06	8.82E+05
.124	7.7	9.60E+05	8.91E+05
.155	2.6	9.10E+05	8.87E+05
.207	9.7	8.30E+05	7.56E+05
.310	-15.0	3.70E+06	4.35E+06
.413	27.2	4.50E+06	3.54E+06
.620	5.1	2.40E+06	2.28E+05
.827	-2.3	1.25E+06	1.28E+06
1.033	-4.5	7.50E+05	7.85E+05
1.240	-5.1	4.90E+05	5.16E+05
1.550	-5.7	2.90E+05	3.08E+05
2.066	-2.4	1.50E+05	1.54E+05
3.100	-18.9	2.95E+05	3.64E+05
4.133	-20.1	1.32E+05	1.65E+05
6.199	-17.0	4.50E+04	5.42E+04
8.265	-12.7	2.15E+04	2.46E+04
12.398	-4.8	7.70E+03	8.09E+03
15.498	.3	4.40E+03	4.39E+03
20.663	703.5	1.60E+04	1.99E+03
30.995	5.8	4.70E+03	4.44E+03
41.327	11.1	2.20E+03	1.98E+03

Table II. Continued

RUTHENIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	26.0	1.08E+06	8.57E+05
.124	16.8	1.06E+06	9.08E+05
.155	6.7	1.02E+06	9.56E+05
.207	8.4	9.50E+05	8.76E+05
.310	-60.3	7.50E+05	1.89E+06
.413	-3.8	3.73E+06	3.89E+06
.620	12.1	2.85E+06	2.54E+06
.827	-.7	1.42E+06	1.43E+06
1.033	-1.0	8.70E+05	8.79E+05
1.240	3.9	6.00E+05	5.78E+05
1.550	-7.0	3.20E+05	3.44E+05
2.066	-9.1	1.55E+05	1.70E+05
3.100	-6.7	3.10E+05	3.32E+05
4.133	-22.7	1.40E+05	1.81E+05
6.199	-19.4	4.80E+04	5.95E+04
8.265	-13.1	2.35E+04	2.70E+04
12.398	-10.0	8.00E+03	8.89E+03
15.498	-6.6	4.50E+03	4.82E+03
20.663	.5	2.20E+03	2.19E+03
30.995	5.3	5.10E+03	4.84E+03
41.327	1.7	2.20E+03	2.16E+03

RHODIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	16.0	1.03E+06	8.88E+05
.124	15.8	1.10E+06	9.50E+05
.155	15.2	1.17E+06	1.02E+06
.207	18.7	1.15E+06	9.69E+05
.310	26.4	1.10E+06	8.70E+05
.413	9.9	4.52E+06	4.11E+06
.620	-2.3	2.55E+06	2.61E+06
.827	-7.5	1.45E+06	1.57E+06
1.033	-4.8	9.20E+05	9.67E+05
1.240	-5.7	6.00E+05	6.36E+05
1.550	-18.3	3.10E+05	3.80E+05
2.066	-17.8	1.55E+05	1.89E+05
3.100	11.5	2.85E+05	2.56E+05
4.133	-12.1	1.72E+05	1.96E+05
6.199	-10.3	5.80E+04	6.47E+04
8.265	-8.4	2.70E+04	2.95E+04
12.398	-5.6	9.20E+03	9.74E+03
15.498	-3.8	5.10E+03	5.30E+03
20.663	-2.7	2.35E+03	2.42E+03
30.995	3.9	5.40E+03	5.20E+03
41.327	6.7	2.50E+03	2.34E+03

Table II. Continued

PALLADIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	4.4	1.10E+06	1.05E+06
.124	-3.6	1.00E+06	1.04E+06
.155	-2.9	1.00E+06	1.03E+06
.207	-.9	1.07E+06	1.08E+06
.310	10.2	9.20E+05	8.35E+05
.413	-4.1	4.10E+06	4.28E+06
.620	-9.8	2.60E+06	2.88E+06
.827	-6.8	1.62E+06	1.74E+06
1.033	2.5	1.10E+06	1.07E+06
1.240	-.8	7.00E+05	7.06E+05
1.550	-9.7	3.80E+05	4.21E+05
2.066	-16.5	1.75E+05	2.09E+05
3.100	283.7	3.00E+05	7.82E+04
4.133	-22.5	1.70E+05	2.19E+05
6.199	640.1	5.30E+05	7.16E+04
8.265	-25.9	2.40E+04	3.24E+04
12.398	401.2	5.30E+04	1.06E+04
15.498	-19.5	4.60E+03	5.71E+03
20.663	-14.8	2.20E+03	2.58E+03
30.995	5.5	5.90E+03	5.59E+03
41.327	2.4	2.60E+03	2.54E+03

SILVER

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	34.1	1.37E+06	1.02E+06
.124	25.5	1.32E+06	1.05E+06
.155	37.3	1.50E+06	1.09E+06
.207	36.0	1.55E+06	1.14E+06
.310	23.1	1.10E+06	8.94E+05
.413	118.4	5.45E+06	2.50E+06
.620	-14.5	2.60E+06	3.04E+06
.827	-24.1	1.42E+06	1.87E+06
1.033	-19.2	9.40E+05	1.16E+06
1.240	-12.7	6.70E+05	7.68E+05
1.550	-30.4	3.20E+05	4.60E+05
2.066	-32.4	1.55E+05	2.29E+05
3.100	105.8	1.77E+05	8.60E+04
4.133	-19.8	1.90E+05	2.37E+05
6.199	-16.4	6.50E+04	7.77E+04
8.265	-14.9	3.00E+04	3.53E+04
12.398	-10.9	1.03E+04	1.16E+04
15.498	-10.6	5.60E+03	6.26E+03
20.663	-8.5	2.60E+03	2.84E+03
30.995	5.3	6.30E+03	5.98E+03
41.327	5.7	2.90E+03	2.74E+03
61.990	13.1	1.00E+03	8.84E+02

Table II. Continued

CADMIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	96.5	1.70E+06	8.65E+05
.124	13.8	1.24E+06	1.09E+06
.155	10.8	1.26E+06	1.14E+06
.207	6.4	1.30E+06	1.22E+06
.310	10.9	1.09E+06	9.83E+05
.413	-3.5	9.20E+05	9.54E+05
.620	27.1	3.45E+06	2.71E+06
.827	8.4	2.20E+06	2.03E+06
1.033	8.9	1.38E+06	1.27E+06
1.240	6.1	8.80E+05	8.30E+05
1.550	9.3	5.40E+05	4.94E+05
2.066	3.3	2.60E+05	2.52E+05
3.100	-16.7	7.70E+04	9.25E+04
4.133	-23.0	2.00E+05	2.60E+05
6.199	-23.3	6.50E+04	8.48E+04
8.265	-21.7	3.00E+04	3.83E+04
12.398	-25.7	9.30E+03	1.25E+04
15.498	-27.5	4.90E+03	6.76E+03
20.663	-31.3	2.10E+03	3.06E+03
30.995	3.1	6.70E+03	6.50E+03
41.327	-2.5	2.90E+03	2.97E+03
61.990	4.6	1.00E+03	9.56E+02

INDIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	50.7	1.60E+06	1.06E+06
.124	18.3	1.25E+06	1.06E+06
.155	23.9	1.45E+06	1.17E+06
.207	23.8	1.60E+06	1.29E+06
.310	4.8	1.12E+06	1.07E+06
.413	27.4	1.00E+06	7.85E+05
.620	24.6	3.65E+06	2.93E+06
.827	9.9	2.42E+06	2.20E+06
1.033	9.4	1.50E+06	1.37E+06
1.240	-.1	9.00E+05	9.01E+05
1.550	2.2	5.50E+05	5.38E+05
2.066	-5.6	2.60E+05	2.76E+05
3.100	-14.2	8.70E+04	1.01E+05
4.133	-1.5	2.30E+05	2.34E+05
6.199	-21.8	7.20E+04	9.21E+04
8.265	-21.0	3.30E+04	4.18E+04
12.398	-19.8	1.10E+04	1.37E+04
15.498	-17.9	6.10E+03	7.43E+03
20.663	-17.0	2.80E+03	3.37E+03
30.995	6.3	7.80E+03	7.34E+03
41.327	3.4	3.40E+03	3.29E+03
61.990	5.8	1.10E+03	1.04E+03

Table II. Continued

TIN

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	214.2	4.20E+06	1.34E+06
.124	88.0	1.85E+06	9.84E+05
.155	91.2	2.30E+06	1.20E+06
.207	55.2	2.10E+06	1.35E+06
.310	16.8	1.35E+06	1.16E+06
.413	6.7	9.20E+05	8.62E+05
.620	-6.1	3.00E+06	3.19E+06
.827	-3.4	2.15E+06	2.23E+06
1.033	-7.2	1.38E+06	1.49E+06
1.240	-8.0	9.00E+05	9.78E+05
1.550	-7.8	5.40E+05	5.86E+05
2.066	-8.6	2.75E+05	3.01E+05
3.100	-17.3	9.20E+04	1.11E+05
4.133	41.2	2.60E+05	1.84E+05
6.199	-20.8	8.00E+04	1.01E+05
8.265	-16.8	3.80E+04	4.56E+04
12.398	-16.1	1.25E+04	1.49E+04
15.498	-14.3	6.90E+03	8.05E+03
20.663	-12.0	3.20E+03	3.64E+03
30.995	10.7	8.20E+03	7.41E+03
41.327	4.4	3.60E+03	3.45E+03
61.990	7.1	1.20E+03	1.12E+03

ANTIMONY

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	62.8	2.60E+06	1.60E+05
.124	81.0	2.25E+06	1.24E+06
.155	58.7	1.95E+06	1.23E+06
.207	48.2	2.10E+06	1.42E+06
.310	73.6	2.15E+06	1.24E+06
.413	33.9	1.25E+06	9.34E+05
.620	94.5	7.00E+06	3.60E+06
.827	14.8	2.72E+06	2.37E+06
1.033	14.3	1.83E+06	1.60E+06
1.240	13.5	1.20E+06	1.06E+06
1.550	18.0	7.50E+05	6.36E+05
2.066	18.9	3.90E+05	3.28E+05
3.100	7.4	1.30E+05	1.21E+05
4.133	25.8	2.40E+05	1.91E+05
6.199	-26.0	7.90E+04	1.07E+05
8.265	-24.4	3.70E+04	4.89E+04
12.398	-23.3	1.25E+04	1.63E+04
15.498	-23.5	6.80E+03	8.89E+03
20.663	-23.9	3.10E+03	4.08E+03
30.995	-1.7	8.30E+03	8.45E+03
41.327	-.8	3.80E+03	3.83E+03
61.990	6.2	1.30E+03	1.22E+03

Table II. Continued

TELLURIUM

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	89.9	2.35E+06	1.24E+06
.124	75.3	2.03E+06	1.16E+06
.155	63.0	1.66E+06	1.02E+06
.207	47.5	2.18E+06	1.48E+06
.310	47.3	1.95E+06	1.32E+06
.413	20.7	1.22E+06	1.01E+06
.620	18.0	6.30E+06	5.34E+06
.827	47.4	3.05E+06	2.07E+06
1.033	22.6	2.10E+06	1.71E+06
1.240	5.6	1.20E+06	1.14E+06
1.550	7.7	7.40E+05	6.87E+05
2.066	6.4	3.80E+05	3.57E+05
3.100	6.0	1.40E+05	1.32E+05
4.133	331.7	2.90E+05	6.72E+04
6.199	-21.8	9.10E+04	1.16E+05
8.265	-19.4	4.30E+04	5.33E+04
12.398	-21.2	1.40E+04	1.78E+04
15.498	-20.5	7.70E+03	9.69E+03
20.663	-21.1	3.50E+03	4.44E+03
30.995	543.3	9.50E+03	1.48E+03
41.327	-1.2	4.10E+03	4.15E+03
61.990	-2.7	1.30E+03	1.34E+03

IODINE

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	264.9	6.60E+06	1.81E+06
.124	174.4	3.00E+06	1.09E+06
.155	61.5	1.70E+06	1.05E+06
.207	18.1	1.80E+06	1.52E+06
.310	38.1	1.95E+06	1.41E+06
.413	30.9	1.43E+06	1.09E+06
.620	1039.6	7.20E+06	6.32E+05
.827	6.9	2.40E+06	2.24E+06
1.033	5.4	1.85E+06	1.75E+06
1.240	-.3	1.23E+06	1.23E+06
1.550	-7.6	6.90E+05	7.46E+05
2.066	-7.1	3.60E+05	3.88E+05
3.100	-18.5	1.17E+05	1.44E+05
4.133	-33.9	4.80E+04	7.26E+04
6.199	-26.0	9.30E+04	1.26E+05
8.265	-28.5	4.10E+04	5.74E+04
12.398	-30.6	1.32E+04	1.90E+04
15.498	-31.4	7.10E+03	1.03E+04
20.663	-28.1	3.40E+03	4.73E+03
30.995	-29.8	1.10E+03	1.57E+03
41.327	4.5	4.60E+03	4.40E+03
61.990	6.8	1.50E+03	1.40E+03

Table II. Continued

XENON

ENERGY (KEV)	PERCENT DIFFERENCE	MCGUIRE	KAMAN
.103	312.3	1.40E+07	3.40E+06
.124	85.3	2.50E+06	1.35E+06
.155	-2.9	1.10E+06	1.13E+06
.207	-27.3	1.00E+06	1.38E+06
.310	-25.3	1.15E+06	1.54E+06
.413	-17.2	1.00E+06	1.21E+06
.620	-10.5	6.30E+05	7.04E+05
.827	-6.6	2.30E+06	2.46E+06
1.033	-5.6	1.80E+06	1.91E+06
1.240	1.3	1.37E+06	1.35E+06
1.550	5.3	8.60E+05	8.17E+05
2.066	-.8	4.20E+05	4.23E+05
3.100	-3.7	1.50E+05	1.56E+05
4.133	-8.1	7.10E+04	7.73E+04
6.199	-17.0	1.10E+05	1.33E+05
8.265	-16.0	5.10E+04	6.07E+04
12.398	-15.8	1.70E+04	2.02E+04
15.498	-18.3	9.00E+03	1.10E+04
20.663	-20.7	4.00E+03	5.04E+03
30.995	-22.5	1.30E+03	1.68E+03
41.327	-.5	4.60E+03	4.63E+03
61.990	.4	1.50E+03	1.49E+03

Table III

Element	Energy (keV)	Percent Difference	M-edges (keV)	L-edges (keV)	K-edge (keV)
Zn (30)	1.03	109%		1.02-1.19	
Ga (31)	10.3	634%			10.37
Kr (36)	1.55	401%		1.67-1.92	
Y (39)	0.155	445%	0.157-0.394		
Tc (43)	20.7	704%			21.04
Pd (46)	3.10	284%		3.17-3.60	
Te (52)	4.13	332%		4.34-4.94	
	31.0	543%			31.81
I (53)	0.620	1040%	0.619-1.072		

NBS-114A (1-71)

U.S. DEPT. OF COMM.
BIBLIOGRAPHIC DATA SHEET

1. PUBLICATION OR REPORT NO.
NBSIR 73-176

2. Gov't Accession No.

3. Recipient's Accession No.

4. TITLE AND SUBTITLE

Comparison of Photon Interaction Cross Data Sets.
VI. McGuire and Kaman Photoeffect Data.

5. Publication Date

6. Performing Organization Code

7. AUTHOR(S)
G. L. Simmons and J. H. Hubbell

8. Performing Organization
NBSIR 73-176

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

10. Project/Task/Work Unit No.
2400432
2400105

11. Contract/Grant No.
DNA-EO-72-804
Subtask No. PC-100-05

12. Sponsoring Organization Name and Address

Defense Nuclear Agency
Washington, D. C. 20305
Support was also received from
NBS Office of Standard Reference Data

13. Type of Report & Period Covered
Interim Report for
period January-Mar.1973

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

Photoeffect cross sections calculated by McGuire, covering the energy range 0.0062 to 62.0 keV for elements with Z = 2 to 54, are compared with values interpolated from results calculated by Veigele et al (Kaman) which cover the energy range 0.1 to between 1.0 and 8.0 keV. This comparison is presented in the form of percent differences between these two data sets, with the Kaman values taken as the reference set. The cross sections are listed and the differences are tabulated over the energy range 0.103 to 62.0 keV, thus at the higher energies the comparison is with Kaman values which were fitted to experimental data. Discrepancies ranged from less than 3% up to as much as a factor of ten in the iodine M_{IV} - M_V edge region at 0.620 keV. From this comparison, and from graphical comparison of both sets with experimental data for carbon, aluminum and tin, we estimate that for Z = 2 to 54 the envelop of uncertainty of the Kaman calculated values in the region 0.1 to 1.0 keV is of the order of ± 20% except in the presence of resonance absorption features where the uncertainty can be an order of magnitude.

17. KEY WORDS (Alphabetical order, separated by semicolons)
Attenuation coefficients; comparison; cross sections; photoeffect; photons; x-rays

18. AVAILABILITY STATEMENT

☒ UNLIMITED.

☐ FOR OFFICIAL DISTRIBUTION. DO NOT RELEASE TO NTIS.

19. SECURITY CLASS (THIS REPORT)
X
UNCLASSIFIED

20. SECURITY CLASS (THIS PAGE)

21. NO. OF PAGES
40

22. Price